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Design using geosynthetics —

Part 9: **Barriers**

Design pour géosynthétiques —

Partie 9: Barrières

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 221, *Geosynthetics*.

A list of all parts in the ISO 18228 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 18228 series provides guidance for designs using geosynthetics for soils and below ground structures in contact with natural soils, fills and asphalt. The series contains 10 parts which cover designs using geosynthetics, including guidance for characterization of the materials to be used and other factors affecting the design and performance of the systems which are particular to each part, with ISO/TR 18228-1 providing general guidance relevant to the subsequent parts of the series.

The series is generally written in a limit state format and guidelines are provided in terms of partial material factors and load factors for various applications and design lives, where appropriate.

For each of the design considerations, the characteristics of the geosynthetics and the test methods normally used to quantify the properties of the geosynthetics are described. Some regional specific rules and regulations that normally apply to designs using geosynthetics in these regions are also mentioned.

This document contains recommendations and guidance for the design of geosynthetic barriers in geotechnical applications. The standard provides design guidance over various applications, design lives, material types, parameters and site-specific conditions. Professional judgement is needed in all designs. Be aware that national regulations might apply. This document is intended to assist in the process, by identifying parameters which are relevant.

Design using geosynthetic barriers (GBRs) takes into account the nature of the material in contact with the GBR, both underneath (the substrate), alongside and on top (the contained substances). As the primary function of a GBR is to retain or exclude fluids, primary issues in design relate to its ability to perform this function. Often, but not always, GBR materials are incorporated into structures with an extensive life expectancy and therefore the material's durability (its ability to continue to perform its primary function over time) is critical.

Balancing the combination of often conflicting performance criteria and different GBR materials to the proposed installation is always a complex matter. This inevitably comes down to professional judgement. This document does not set out to and cannot solve this potential conflict but seeks to assist the designer in identifying and clarifying the various components of the decision-making process by identifying existing standards for comparisons of individual parameters and giving some direction on prioritization in various applications as well as conflicting performance characteristics which may be encountered.

Design using geosynthetics —

Part 9:
Barriers

1 Scope

This document considers the guidance for geotechnical and civil engineers involved in the design of the barrier function.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10318-1, *Geosynthetics — Part 1: Terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 10318-1:2015 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
barrier
use of a geosynthetic to prevent or limit the migration of fluids

3.2
geosynthetic barrier
GBR
low-permeability geosynthetic material, used in geotechnical and civil engineering applications with the purpose of reducing or preventing the flow of fluid through the construction

3.3
geomembrane
GBR-P
polymeric geosynthetic barrier
factory-assembled structure of geosynthetic materials in the form of a sheet in which the *barrier* (3.1) function is essentially fulfilled by polymers

3.4
clay geosynthetic barrier
GBR-C
geosynthetic clay liner
factory-assembled structure of geosynthetic materials in the form of a sheet in which the *barrier* (3.1) function is essentially fulfilled by clay

3.5
bituminous geomembrane
bituminous geosynthetic barrier
GBR-B
factory-assembled structure of geosynthetic materials in the form of a sheet in which the *barrier* (3.1) function is essentially fulfilled by bitumen

4 Pictograms

4.1 Product and function

Graphical symbols and pictograms for geosynthetic barriers can be found in ISO 10318-2:2015.

4.2 Applications

4.2.1 Containment application, non-landfill (CA)

GBRs are used to inhibit the ingress of water and the uncontrolled escape of fluids in or out of the construction (see Figure 1). The minimum confining stress is typically of the order of 20 kN/m^2.

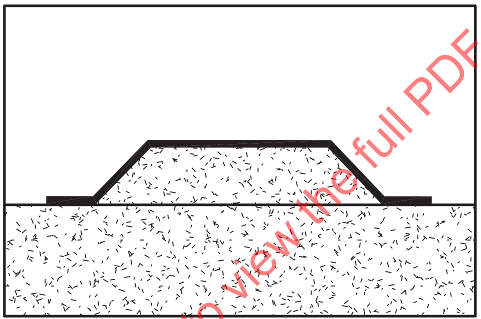

Figure 1 — Containment application, non-landfill (CA)

4.2.2 Chemical containment, non-landfill (CC)

The function of the GBR in this application is to contain any hazardous liquids or constituents within a construction. The typical confining stress is in the range of less than 50 kN/m^2, whereas the hydraulic gradient *i* is typically less than 500. See Figure 2.

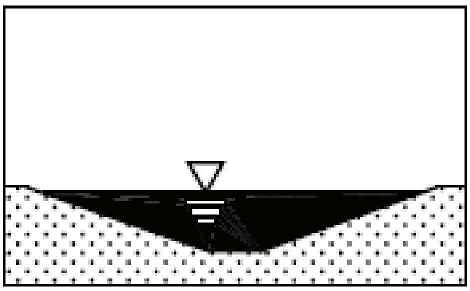

Figure 2 — Chemical containment, non-landfill (CC)

4.2.3 Construction waterproofing (CW)

The function of the GBR in this application is to inhibit the passage of water into the underground structures (other than tunnels and associated structures). The typical confining stress is less than 100 kN/m^2 and the gradient can be up to 400, however both can be much higher. See Figure 3.

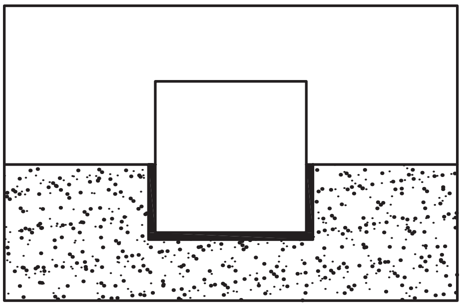

Figure 3 — Construction waterproofing (CW)

4.2.4 Landfill base lining (LBL)

GBRs are used to inhibit the ingress of groundwater and the uncontrolled escape of landfill leachate and/or gases in the construction of solid waste storage and disposal sites as base liners. The typical confining stress is in the range of 50 kN/m^2 to 1 000 kN/m^2, whereas the hydraulic gradient i is typically less than 50. See Figure 4.

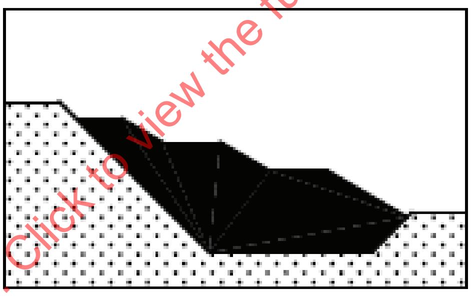

Figure 4 — Landfill base lining (LBL)

4.2.5 Landfills caps (LC)

GBRs are used to inhibit the ingress of water and the uncontrolled escape of fluids and/or gases in the construction of solid or industrial waste facilities. The typical confining stress is in the range of 10 kN/m^2 to 50 kN/m^2. See Figure 5.

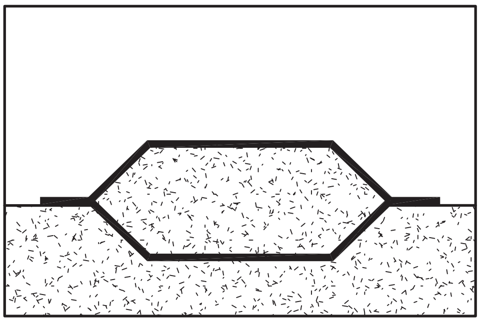

Figure 5 — Landfills caps (LC)

4.2.6 Secondary containment (SC)

The function of the GBR in this application is to contain any hazardous liquids or constituents resulting from storage silos or similar containment failures. The typical confining stress is in the range of less than 25 kN/m^2, whereas the hydraulic gradient i is typically less than 150. See Figure 6.

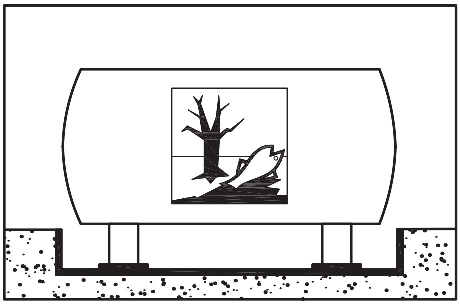

Figure 6 — Secondary containment (SC)

4.2.7 Transport infrastructure applications (TIA)

The function of the GBR in these applications is to inhibit any hazardous liquids or constituents resulting from vehicle, railway or airline traffic entering the sensitive location, mainly in infrastructure applications, such as roads, railways and airports. The typical confining stress is in the range of less than 50 kN/m^2, whereas the hydraulic gradient i is typically less than 50. See Figure 7.

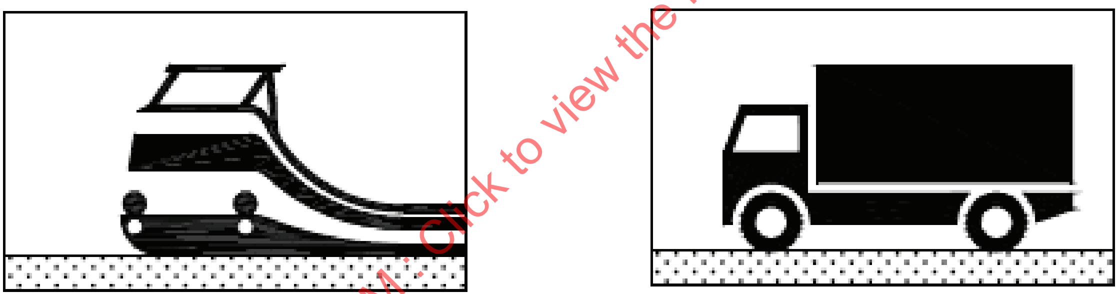

Figure 7 — Transport instrastructure application (TIA)

4.2.8 Tunnels (Tu)

The function of the GBR in this application is to inhibit the passage of water into the construction of tunnels and associated underground structures. The typical confining stress in a cut and cover application is in the range of less than 100 kN/m^2 and a gradient up to 400. In bored applications the confining stresses and gradients are typically much higher. See Figure 8.

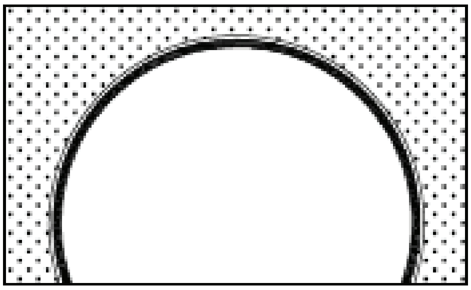

Figure 8 — Tunnels

4.2.9 Water retaining structure (WRS-e), e.g. balancing ponds, dams, dykes and canals (usually empty)

In applications with a temporary water level such as balancing ponds, dams, dykes and canals, GBRs are mostly used as the sole hydraulic barrier or in combination with an existing soil barrier. The function of the GBR is to reduce seepage through the system thereby reducing water loss and providing environmental protection. The typical confining stress is less than 50 kN/m^2, whereas the hydraulic gradient is typically higher than 100 and can reach many hundreds. See Figure 9.

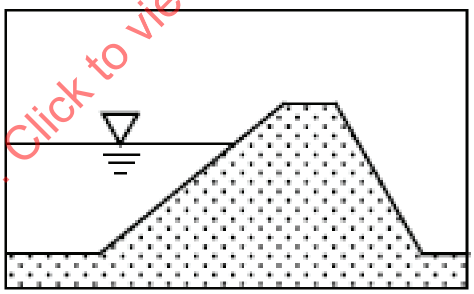

Figure 9 — Water retaining structure (WRS-e)

4.2.10 Water retaining structure (WRS-f), e.g. reservoirs, canals (usually full)

In applications where a constant water level is maintained such as canals, rivers and surface impoundments, GBRs are mostly used as the sole hydraulic barrier or in combination with an existing soil barrier (such as a clay core within a dam structure). The function of the GBR is to reduce seepage through the system thereby reducing water loss from the waterway or storage impoundment. Additionally, it is used to prevent the weakening of the internal structure of the dam. The typical confining stress is less than 50 kN/m^2, whereas the hydraulic gradient i is typically higher than 100 and can reach many hundreds. See Figure 10.

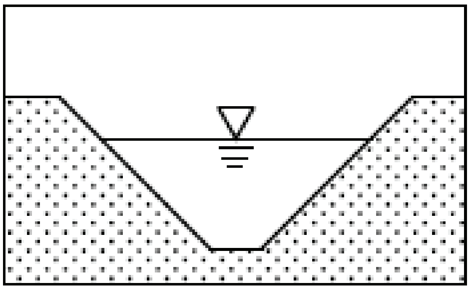

Figure 10 — Water retaining structure (WRS-f)

5 Design Criteria

This Clause presents key design criteria that could be addressed for proper hydraulic and mechanical performance of a GBR. There are other issues as well. In general, the designer could go beyond this document into the idiosyncrasies of the product-specific and site-specific considerations. GBRs in this document are products to limit the movement of fluids and/or gases. Table 1 suggests various applications, with ratings from 1 (important) to 4 (not relevant), and selected criteria that might be applicable for design consideration. In all cases, product-specific and site-specific conditions can prevail.

Table 1 — Subjective ratings for importance of various criteria of common GBR applications

Characteristic parameter		**CA**	**CC**	**CW**	**LBL**	**LC**	**SC**	**TIA**	**TU**	**WRS-e**	**WRS-f**
Chemical resistance		2	1	3	1	2	1	1	2	3	3
Physical properties											
Hydraulic resistance	permeability	1	1	1	1	1	1	1	1	1	1
Mechanical property	tensile, puncture, tear strength	1	1	2	1	1	2	1	1	1	1
	uni- and multi-axial elongation	2	2	3	3	2	2	2	3	2	2
Abrasion resistance		4	4	4	4	4	4	4	4	2	2
Durability		50 yrs	25 yrs	50 yrs	100 yrs	50 yrs	25 yrs	25 yrs	100 yrs	25 yrs	25 yrs
Installation		1	1	1	1	1	1	1	1	1	1
Key 1: Important 2: Project-dependent requirement 3: Rarely required 4: Not relevant											

Vertical barriers are sometimes used within a support fluid, (i.e. bentonite, cement-bentonite or mixed in place material) in an excavated trench. The support fluid needs to be of such density that the trench remains open. It is also recommended to review the site investigation data for any possible obstructions during installation or integrity of the system (i.e. boulders, roots or other debris) and contact a specialized designer or contractor. The system needs to terminate in an impermeable stratum to ensure water tightness.

6 Materials

6.1 General

GBRs are manufactured from various compounds offering different performance criteria. 6.2 to 6.11 describe those most commonly in use.

6.2 HDPE

HDPE (high density polyethylene) resin for geomembranes is a hydrocarbon polymer prepared from ethylene/petroleum by a catalytic process. The molecular chains are linear, and the resin is semi-crystalline. The geomembranes are produced by extrusion or blown film process and for stabilization properties about 2 % carbon black is added. HDPE geomembranes have a very high resistance to chemicals and the density is ≥ 0,940 g/cm^3.

6.3 LLDPE

LLDPE (linear low-density polyethylene) is a hydrocarbon polymer. The molecular chains are short and branched. The density and crystallinity are lower than HDPE and therefore it is more flexible without using plasticizer. The molecular chains are linear, and the resin is semi-crystalline. The geomembranes are produced by extrusion or blown film process and for stabilization properties about 2 % carbon black is added. The typical density for geomembranes is between 0,920 g/cm^3 and 0,935 g/cm^3.

6.4 fPP

Flexible Polypropylene, fPP (per ASTM D4439) is a material having a 2 % secant modulus of less than 300 MPa (40 000 lb/in^2) as determined by ASTM D5323 produced by polymerization of propylene with or without other alpha olefin monomers.

6.5 PVC

PVC (polyvinyl chloride) geomembranes are produced from blends of rigid PVC and plasticizer (Phthalate). The quantity of plasticizer, depending on the type, can be up to 40 %.

6.6 EPDM

EPDM (ethylene propylene diene monomer) geomembranes are made from synthetic rubber ethylene-propylene-diene terpolymer, which is mixed with carbon black and other compounds, e.g. clay, oils, processing aids. It is a vulcanized cross-linked rubber sheet.

6.7 Bitumen

Bituminous membranes mainly consist of a polymer/elastomeric blended bituminous layer on a synthetic fabric. Bituminous geomembranes are between 3,0 mm and 5,0 mm thick and they can consist of many different layers with different functions (sanded surface layer, polyester films).

6.8 EIA (ethylene interpolymer alloy)

EIA geomembranes consist of a PVC blend with a modifier on an ethylene copolymer basis. The modifier resin increases the properties of the base resin, e.g. durability, flexibility.

6.9 Bentonite

Bentonite is an absorbent aluminium silicate clay formed from volcanic ash.

6.10 Sodium bentonite

Sodium bentonite for use in geosynthetic clay barriers (GBR-C) is characterized by having sodium as its predominant exchangeable ion. Sodium bentonite is not itself a mineral name, but more correctly, it is a smectite clay composed primarily of the mineral montmorillonite.

6.11 Calcium bentonite

Calcium bentonite for use in geosynthetic Clay barriers (GBR-C) is characterized by having calcium as its predominant exchangeable ion. Calcium bentonite is not itself a mineral name, but more correctly, it is a smectite clay composed primarily of the mineral montmorillonite.

Table 2 considers appropriate compound selection in a given design.

Table 2 — Compound selection of a GBR to determine the suitability in a selected application

Barrier Type		CA	CC	CW	LBL	LC	SC	TIA	TU	WRS-e	WRS-f
GBR-P	HDPE	1	1	2	1	1	1	1	2	1	1
	LDPE	1	2	2	2	2	1	1	1	1	1
	PVC	3	4	3	4	3	4	3	2	2	1
	EPDM	3	4	3	4	3	4	3	3	1	1
	PP	3	3	3	4	2	3	2	3	2	2
GBR-C	Single-component	2	3	2	2	1	3	1	3	2	2
	Multi-component	2[a]	2[a]	2[a]	2[a]	1[a]	2[a]	1[a]	2[a]	2[a]	2[a]
GBR-B		3	3	2	4	3	3	2	2	2	2

Key

1: World-wide acceptance

2: General acceptance

3: Rarely used

4: Not recommended

[a] Compare with the relevant combined component.

7 Properties relevant to design

7.1 General

7.1.1 For all designs the following basic parameters are relevant:

— Chemical resistance;

— Physical properties;

— Durability/weathering.

Most decision-making processes would typically come down to a combination of the above three distinct parameters, essentially what the GBR is required to do, under what circumstances and for how long. The expected lifetime of the GBR and the substrate is normally equivalent to design life.

7.1.2 Chemical resistance applies to:

— the material(s) from which the GBR is made;

— the finished product; and/or

— any combination of GBR materials if used in conjunction (and jointing techniques).

7.1.3 Physical properties apply to:

— the GBR itself;

— any structure to which the GBR may be fixed or over which it is placed; and

— any jointing techniques used.

7.1.4 Durability/weathering applies to:

— the constituent materials;

— the finished products; and

— any jointing methods.

A considerable amount of information is available to the designer to refine their decision-making process, as given in 7.2 to 7.4.

7.2 Chemical resistance

7.2.1 Chemical resistance of the material(s) from which the GBR is made:

— Available from the component material's supplier, often from chemical analysis and polymer science as well as distinct immersion testing.

7.2.2 Chemical resistance of the finished product:

— International, regional and domestic standards exist for testing GBR materials against a whole range of chemicals regularly found in the ground as well as those for which GBRs are used to contain and/or exclude.

7.2.3 Chemical resistance of any combination of GBR materials if used together (and jointing techniques):

— As above, the testing may include or be extended to combinations of GBR components if the design parameters make it clear that different elements of the GBR can be subjected to different conditions, e.g. separate jointing compounds.

7.3 Physical properties

7.3.1 Physical properties of the GBR itself (available from manufacturers or testing facilities):

— Hydraulic resistance (permeability, permittivity, index flux, vapour transmission and/or diffusion rates);

— Mechanical and elongation properties (tensile strength, peel strength, abrasion resistance, tear resistance and/or puncture resistance);

— Deformation properties (multi-axial);

— Compressive behaviour (deformation under load);

— Any jointing techniques used (shear or peel strength, continuity, hydraulic performance as appropriate).

7.3.2 Physical properties of any structure to which the GBR is fixed or over which it is placed:

— Hydraulic resistance additional to the membrane (low permeability substrates, e.g. clay, waterproof concrete, add to the confidence in the system);

— Frictional performance (interface properties, internal shear strength);

— Stability (GBR would not normally support the substrate, e.g. prevent settlement).

7.4 Durability/weathering

7.4.1 General

Durability consists of two very separate and essential considerations. The resistance of the materials to mechanical damage both during and post installation, and the long-term durability of the material to climatic service conditions both need consideration (often in parallel).

7.4.2 Mechanisms of degradation of the GBR

The durability of a geosynthetic barrier depends on various mechanisms that cause degradation, i.e. reduction of mechanical or hydraulic performance. These mechanisms can be summarized as the following:

a) attack by oxygen accelerated by elevated temperature, exposure to UV light, or repetitive mechanical stress and catalysed possibly by chemicals, e.g. heavy metals;

b) hydrolytic attack of the geosynthetic barrier or its components/additives accelerated by elevated temperature, acidic and alkaline conditions;

c) solvation, i.e. change in physical properties due to absorption of liquid chemicals;

d) environmental stress cracking, i.e. the mechanical failure of the geosynthetic barrier at stresses less than its yield strength in the presence of certain chemical species;

e) microbiological attack which includes the action of bacteria, fungi, and roots;

f) leaching of soluble components/additives of the geosynthetic barrier, thereby directly or indirectly affecting its mechanical properties or its resistance to other forms of degradation; and

g) the loss of plasticizers and by dehydrochlorination.

7.4.3 Mechanisms of degradation of the joints

Jointing methods are designed to suit each type of GBR and offer the best possible combination of properties mirroring most closely those of the parent material. Jointing methods using a separate material (e.g. glues, tapes) are particularly sensitive to durability issues but deterioration in performance due to melt type welding jointing is equally important.

Mechanisms of degradation of the joints of the substrate to which or over which the GBR is laid:

— GBR design would not normally form part of the stabilization of the substrate other than reducing hydraulic permeation from above. One of the areas most overlooked in GBR design is the effect of the substrate over which the GBR is laid. Long term performance relies completely on the substrate and GBR installation being designed together.

8 Principles of design

8.1 General

The GBR and its substrate form the construction which has an expected design life and would normally be considered as a primary part of the process. It is important not to select low cost, low performance materials just because the structure only has a short life. If the potential risk of failure of the structure is high, then this would override the financial aspects of the design process but can still impact the required lifespan of the components.

The whole process is overshadowed by an assessment of the risk versus value equation. Designers would normally consider the whole range of issues and feed into a pragmatic risk assessment process such that the ultimate design, its components and its installation provide an appropriate completed system, including sufficient factors of safety commensurate with the consequences of failure, be they limited or catastrophic.

8.2 Subgrade preparation

The performance of any lining system also depends on the condition of the prepared subgrade. Earthworks are used to ensure the liners long-term performance and includes subgrade preparation and cover soil placement. A proper subgrade preparation is one critical part, since the subgrade is the founding surface for the lining system.

Depending on the lining system, different soil types might be applicable as a prepared subgrade. This includes locally available soils, imported soil material or mixed on-site soils. A general rule is, that fine grained, non-cohesive soils, such as sand or silty sand and most cohesive soils, such as clayey-silt glacial till, are suitable as subgrade construction material. In case of coarser subgrade material, the suitability of these needs to be confirmed. Although these coarser materials can be graded and compacted to a uniform and subgrade surface, it might be necessary to further improve the direct contact surface with a fine grain material (e.g., sand) or a geosynthetic cushion nonwoven. A sand material needs to have a minimum thickness of 100 mm and be compacted to ensure a minimum bearing capacity. It is crucial that any prepared subgrade is compacted in accordance with design specifications or standard engineering practice. A compaction to a minimum of 95 % of maximum dry density according to a standard Proctor test is a guidance. In any case, the applicability of any subgrade material and the compaction value needs to be approved by the responsible design engineer.

The prepared surface should be homogeneous, uniform, well-compacted, and free of any sharp rock fragments or stones, large stones and other foreign matter such as branches, roots, construction debris or other sharp objects, which could damage the lining system and provide sufficient bearing capacity. Any stones, rocks, clay lumps and foreign debris that lie above the subgrade surface should be removed.

During the installation of the geosynthetic barrier vehicles might need to drive over the subgrade but these occurrences need to be limited. Possible ruts, deformations or other marks left in the subgrade need to be repaired to the approved origin. Likely effects on the subgrade due to rainwater, desiccation, freezing and thawing need to be avoided, e.g. by means of immediate installation of the geosynthetic barrier. A geotextile cushion nonwoven could be used to correct an imperfect surface.

8.3 Slope stability

In order to ensure safe and reliable stability analysis, dimensioning and design, it is important to have detailed information on each single shear plane. Safety is therefore top priority for all applications, especially on slopes. Based on many years of experience with various geomembrane structures it is clear that an improved uniform friction surface results from an embossed profile of the same resin material, creating a homogeneous connection between the liner and the interface structure.

However, a project specific analysis would normally be performed, including direct shear testing, to confirm slope stability calculations. In cases where slope stability is not ensured with an accepted safety factor, geogrids can be used to improve the stability of soil veneers or entire lining systems.

8.4 Climate conditions

Climate conditions might also be important to consider, especially if the geosynthetic is exposed for a longer period. Higher elevations can increase heating by solar radiation, exposure to UV but also temperature changes. Additional construction considerations can include:

— effect of strong wind;

— high rain fall; and

— snowfall.

8.5 Temperature effects (thermal expansion and stiffness)

When exposed to variations in temperature, some geomembranes expand and contract, potentially impacting their integrity and effectiveness (see Table 3). Geomembranes made from un-reinforced polymeric materials are most susceptible to the effects of thermal expansion and contraction. As most geomembrane materials are black in colour their ability to heat under solar radiation is high and it is quite possible for the surface temperature of a black geomembrane to reach 80 °C at midday and reduce to 10 °C at midnight, making a 70 °C variation in 24 h. A polyethylene membrane with a 70 °C temperature change can cause a 100 m section to increase by up to 1,5 m.

Table 3 — Thermal expansion and contraction of a geomembrane

Geomembrane material	Coefficient of thermal expansion (cm/cm/°C)	Increase in length over 10 m for a 50 °C temperature variation (mm)
HDPE	2×10^{-4}	100,00
FPP un-reinforced	12×10^{-5}	60,00
PVC	12×10^{-5}	60,00
FPP reinforced	2×10^{-6}	1,00
Bitumin	2×10^{-6}	1,00

The thermal expansion and contraction of a geomembrane can affect its ability to lie flat on a slope or base, can cause folds to appear and can create stresses in an installed membrane such that necking occurs or welds are pulled apart. It can also cause bridging or “trampolining”, particularly at the base of slopes. Membranes fixed to immovable points such as pipe penetrations and mechanical fixing to structures are particularly at risk.

It is important to match the type of material to the application or ensure that thermal expansion and contraction does not affect the overall design.

8.6 Protection and testing

8.6.1 Puncture protection

To limit physical damage (e.g. strains and/or material thinning) from an overlying granular layer, a protection layer might be required above the GBR in various applications. Details on testing and design are covered in document number EN 13719.

8.6.2 Installation issues, excluding jointing

8.6.2.1 Materials handling and storage

It is important to supervise the unloading of the membrane and make arrangements for safe storage. Appropriate machinery would normally be available on the site for lifting and transporting the membrane. Lifting and carrying would normally be performed using slings or core bars. Under no circumstances allow the membrane to be handled with the tines of a forklift machine, the bucket of an excavator or any similar equipment. The storage area would normally be prepared so as to minimize the potential for damage. If stored for considerable time before use, the materials need to be protected from environmental degradation in accordance with manufacturer's recommendations.

8.6.2.2 Cover materials

Protection of geomembranes is frequently achieved by the cover material itself, being granular materials such as sand or other fine grade material or by a further geosynthetic, typically a non-woven needle punched geotextile. In either case it is desirable to undertake suitable testing either in a laboratory or on site to ensure suitability of the chosen material in site specific circumstances.

8.6.2.3 Installation

Geomembrane panels or rolls are installed to a predetermined plan. This is particularly critical in irregularly shaped excavations to minimise the folding or excessive cutting and reforming of material in the corners Often material is delivered to site as rolls up to 250 m long and 5 m to 10 m wide. The nature of the membrane determines the layout of the sheets. Ideally the number of welds and amount of patching needs to be minimized. Welds would normally run down a slope or be on the flat base.

In windy conditions, the sheets need to be weighted down with sandbags or similar immediately after unrolling to prevent the sheet moving during welding.

8.6.3 QC on site

The following description includes all materials from Clause 6. Geomembranes with smooth and textured surfaces are included.

The installation crew needs to have knowledge of the installation instructions presented by the manufacturer or instructions for the installed product.

All testing activities (see Table 4) would normally be performed by the material installer. Testing would normally be done as the seaming work progresses, not at the end of all seaming works.

Test seams or trial welds would normally be prepared and tested by the geomembrane installer to verify the seaming parameters. These seams would normally be made by each welding technician in accordance with the material specific standards at the beginning of each seaming period (minimum once per day). The test seam would normally be produced with the same equipment and under the same conditions as the on-site welding. A test seam of sufficient length would normally be produced for each type of welding seam (e.g. double seam, extrusion seam or bonded joint).

From each seam, five test specimens would normally be cut for testing the seam strength using a field tensiometer. The required values and tests are different for each material (see Table 1) and can be found in existing standards or in the installation instructions. If the test seam fails an additional test seam needs to be produced.

All field seams would normally be non-destructively inspected for outer appearance over the full seam length of every weld before the seams are covered. Each seam would normally be numbered or otherwise designated. The location, date, test unit and seam dimensions would normally be recorded, as well as the following:

a) structure and uniformity of the seam path;

b) bulging on the front weld edge in the case of lap welded joints and in the boundary region in the case of surface seams;

c) central position and uniform boundary regions in the case of surface seams;

d) notches and grooves in the weld region; and